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ABSTRACT

At most schools and universities, the traditional roles of the library and computing services organizations have begun to converge as the technologies they use to store, transmit, and retrieve information and, in some cases, the information itself, become increasingly similar. Examples of the changing patterns of information storage and retrieval in libraries and educational resource centers in the United States include the use of optical disk technology; direct end-user searching of online databases; library networks; the automation of library processes such as acquisitions, cataloging, serials control, and circulation; the electronic delivery of information; and the development of electronic publishing. Several issues surround these changing patterns, including the high cost of the new technologies; increased user expectations; changing definitions of "library" and "collection"; intellectual property rights; lack of standardization of format, equipment, and search protocols; and the increasing need for training. In view of these changes, the major challenge facing the field of educational technology is to take a leadership role in applying these new information technologies to users and learners at all levels and in all settings. (KM)

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CHANGING PATTERNS OF INFORMATION STORAGE AND RETRIEVAL IN AMERICAN LIBRARIES AND EDUCATIONAL RESOURCE CENTERS

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

It is a pleasure to bring you greetings from the University of Michigan, which has many graduates in Japan. I am also pleased to be representing the Association for Educational Communications & Technology, in which I hold the office of President-Elect. It is indeed an honor to be here with you to share our mutual perspectives on developments in the field of educational technology.

The intent of today's session is to provide an overview of the changing patterns of information storage and retrieval in libraries and educational resource centers in the United States. Although there are many areas of the field we could discuss, six aspects have been selected for examination today. We will also review some of the difficult issues surrounding these developments and their implications for education and scholarly communication at all levels.

The educational process in most countries encompasses many objectives. In the early years of schooling, this begins with the goal of helping young people to learn and mature, and develops through high school, university and post-graduate study to an emphasis on advancing the frontiers of knowledge. All of these objectives rely on the ability to create, transmit, store and use information. In recognition of information's central role in the educational process, the symbolic center of every school and university has historically been the library or, as it is called frequently called now in elementary and secondary schools, the media center or the educational resource center.

Over the past 20 years, libraries and educational resource centers have vastly increased their use of new technologies for the management, storage and retrieval of their information resources, and they are beginning to use even newer technologies for the delivery and packaging of information.

At the same time, organizations known in schools and universities as computing centers, or data processing services, have been moving steadily from

a focus on the manipulation of numeric information to a broad role that encompasses information in all of its forms. Indeed, computers are increasingly being used to process information, i.e., for word processing or graphics production, as well as for statistical analysis and other processing of numeric data.

At most schools and universities, the traditional roles of the library and computing services organizations have begun to converge as the technologies they use to store, transmit and retrieve information and, in some cases, the information itself, become increasingly similar. Along with this convergence in role and overlap in use of technology, a new phrase, "information technology", has come into popular use. In the United States, "information technology" is used to reflect this integration of the telephone, computer, video, optical disk and satellite communication technologies for the storage, retrieval, transmission and overall management of information.

As organizations which are both labor intensive and inventory intensive, libraries are perfect candidates for technology. For our discussion today, I have selected six examples to illustrate the changing patterns of information storage and retrieval in libraries and educational resource centers in the United States.

1. Optical Disks: Video Disk and CD-ROM

Most important among new techniques being used for information storage and retrieval is the optical disk technology used for video disks and compact disks. CD-ROM, with its incredible high density storage capacity of 275,000 pages of text, was introduced to the United States in November of 1984. Over the past two years, CD-ROM has become the most popular format for high density storage because it provides virtually instant random access, high quality graphics, integration of graphics and textual material and unlimited usage without online communication charges.

Video and compact disks, sometimes referred to as "desktop" databases, are being used for numerous applications where information is already available in electronic form, as in the case of specialized bibliographic and statistical databases. Some of these contain business and financial information on corporations, characteristics of poisons and drugs for use in emergency medical diagnosis, as well as indexes to government publications, holdings of major libraries and publishers' lists of books currently in print. There is increasing interest in the use of optical disks, particularly CD-ROM, for full text publishing of newspapers and scholarly journals.

Other applications utilize the capability of optical disks to integrate graphics and text, as in the case of U.S. Patent Office files, where information and pictures of 700,000 patents are stored on eight video disks. The National Gallery of Art has published a disk showing multiple views of more than 1,000 paintings from its collection. Similarly, disks are being used to store vast collections of medical and dental pathology slides. There is even an entire encyclopedia available on compact disk.

As may be evident from these examples, optical disk technologies are being used primarily for storage and retrieval of specialized information in business, law, medicine and the sciences. While there is some use of interactive video disks for instruction in schools, most applications of optical disks for high density storage are being developed for business, professional and university applications where quick access to current information is essential and where funds are available to make new products marketable.

2. Direct End User Searching of Databases

Another changing pattern in information storage and retrieval involves direct end-user searching of online databases. Large academic libraries have been providing online database searching by librarians for more

than ten years. Just as many of the desktop optical disk databases mentioned previously are intended for direct searching by the user, several of the online database utilities are providing simplified searching protocols or reduced rates for evening use of their online systems. Some of these systems are highly specialized (LEXIS for law and accounting, Dow Jones News/Retrieval for business information), while others provide access to more general information (BRS After Dark).

Many of these systems require substantial training for users to be able to maximize their value. As with other technologies, there is a significant relationship between the success of a system and users' skill and comfort in applying it. Direct searching of databases by users provides them with increased independence and opportunity to explore areas of interest, with the result that they search more frequently and more thoroughly as their skills expand.

3. Networks

Another development changing information storage and retrieval in the United States involves networking. There are numerous examples of networks linking libraries in the United States. One of the largest and most important is the Research Libraries Information Network (RLIN), which is an automated information system containing more than 20 million records of books, serials, maps, films, musical scores and sound recordings. This cooperative database, located at Stanford University in California, is used for acquisition, authority control, cataloging and searching purposes by more than 70 research libraries.

There are also many examples of local networks linking various types of libraries in a region for purposes of interlibrary loans or automated circulation, or providing special databases of local information. One such network is called Maggie's Place, which is a cooperative effort of the Pike's

Peak Library District in Colorado and the United Cable Television Corporation. These two agencies developed a community information system based in a computer at the library (called Maggie) and accessed via two-way interactive cable TV and microcomputers.

In addition to providing online information about library holdings, the system has a series of local databases and lists of community services, including carpool openings, clubs and organizations, calendar of events, day care facilities and course listings for local colleges. This network is accessed via remote terminals in branch libraries, grocery stores and elsewhere, and has been extremely popular in the community.

4. Library Automation

A related development which is having a major impact on information storage and retrieval in American libraries is automation of library processes such as acquisitions, cataloging, serials control and circulation. Once library records are available online, patrons are able to check the status of items on order or checked out to someone else and, through the use of a terminal and modem, are able to do so remotely, without ever physically going to the library. This ability to search library holdings online also makes it easier to check many more subject headings and related topics than would be feasible in a large collection with hundreds of drawers of catalog cards.

The advent of online catalogs offers users a substantial improvement in access to information resources, while at the same time increasing usage of and demand for library materials. Many libraries have automated specific functions, such as circulation, using separate mainframe or even microcomputer programs, but the trend is toward integrated library automation systems where a single database contains the master records for each item from the time it is ordered, through the receipt and cataloging process, to circulation and eventual withdrawal from the collection.

5. Document Delivery

The ability to access information remotely, whether to search a database or to check the library's holdings, leads directly to new developments in document delivery and electronic publication. After identifying a citation to a journal or a particular book via an online search, it is entirely logical that one be able to electronically request delivery of an article or book to one's office. A very few libraries have begun to offer this service.

In my own library at the University of Michigan, we offer this service free of charge for our faculty, and will deliver books or copies of articles from our own collection or from any other library on campus. We also provide reference service via electronic mail, so patrons can receive specialized assistance without ever coming into the library.

Another means of document delivery being used in some libraries is telefacsimile, whereby articles or other brief information can be transmitted via telephone communication links to users in remote locations. This technique is widely used in business for transmission of time-critical information, but is only beginning to be applied in the library setting.

The electronic delivery of information makes increasing sense as the form or source in which the information appears is increasingly electronic in nature.

6. Electronic Publication

Several years ago, in his book Telecommunications and Libraries, F.W. Lancaster reported findings of a Delphi study on the future of electronic publishing. Participants predicted that by 1990, 25% of existing reference books would be available only in electronic form, and by the year 2000, 50% of existing abstracting and indexing services would be available only in electronic form. These figures are nowhere near being achieved due to the

high communications costs for online access and the propensity of scholars to browse through printed publications. It is important to remember, however, that these predictions precede the advent of the CD-ROM technology by several years, so the concept may yet be achieved.

The concept of electronic publication is also applicable on the local level. Scholars, who generally use word processing to prepare their writing, could easily enter their working papers into the university library's online catalog as a temporary record, enabling immediate access by other scholars. The electronic paper could be submitted for regular jury review and then "published" in an online journal or CD-ROM format, to be laser printed as needed.

Electronic publication is definitely a viable means of improving the process of scholarly communication, avoiding the long delays associated with printed publications as well as the problems of physical deterioration of printed materials.

Thus far today we have reviewed six areas where the world of information storage and retrieval is rapidly changing in American libraries and educational resource centers. In some libraries, these activities are only beginning to occur. In other libraries, like my own, the change has been very rapid and many of these applications are taking place. From the point of view of our students, the most exciting developments have been the installation of six workstations for searching of specialized optical disks and online databases, and the placement of 20 microcomputers throughout the library. From the faculty members' point of view, document delivery has been a tremendous asset to their research productivity. We are also involved in the RLIN network, which we use for reference searching and shared cataloging information, and are planning large-scale integrated library automation, but these are behind the scenes activities less visible to our users.

ISSUES AND IMPLICATIONS

What are the issues surrounding these changing patterns of information storage and retrieval, and what are their implications for education and scholarly communication?

1. High Cost of New Technologies

There is a major change in the economics of access to information. Information is increasingly being viewed as a commodity, as an entity having value and which can be bought and sold. The high cost of the new technologies, which in many cases re-package information in more compact and easily accessible ways, has significant implications for libraries and educational institutions.

Many libraries have debated whether to charge fees for the use of the new online services. Most have decided to charge at least partial cost to the user with the justification that they cannot afford to provide the service at all for free. This problem is exacerbated by the new desktop databases, for which the library pays a substantial set fee in return for unlimited use. In addition, libraries must be aware of the significant additional costs which accrue in heavily used libraries for such simple entities as paper and ink used to print citations off the disk.

Libraries without the resources to absorb the cost of these new services (and the equipment to support them) are tending to avoid them altogether, thus denying their patrons the benefits of these new information resources. This is a particular problem for elementary and secondary school library media centers, where high cost and low frequency of use of a specialized database or index make acquisition infeasible. Thus, the economics of the new information storage and retrieval devices have a strong impact on equity of access.

2. Increased User Expectations

There are increased user expectations as a result of the new online catalogs and optical disk databases. Citations and brief entries are soon not enough, and users demand that full text of journal articles be available online and that books be delivered to their door. There is also the expectation that all scholarly research is as easy as sitting at a terminal and typing in the desired subject heading. Students forget that indexes are only as good as those who prepare the index, and that substantial effort is needed on their part to analyze and synthesize the vast volume of raw information which can so easily be retrieved with the new technologies.

3. Changing Definition of Library

There are changing definitions of "library" and "collection" as libraries are no longer limited by or restricted to resources within the physical building. Given limited funds, libraries are making choices about which items to purchase and which resources should be accessed as needed, whether borrowed from another library or printed from an online database. These changes will trigger interesting policy questions regarding allocation of resources for physical versus electronic access, raising questions about usage and relative value of various sources and formats.

Similarly, the role of librarians is also evolving from an emphasis on organization and retrieval of physical materials to an emphasis on broad knowledge of electronic sources and on the ability to teach users how to plan research strategy and utilize complex databases. Librarians are also beginning to function outside the traditional organizational structure, setting up businesses as independent information brokers.

Libraries planning new facilities should consider whether they will truly need more space, as the physical growth of the book and journal collections may be minimal and patrons choose to contact reference librarians

via electronic mail rather than coming to the library in person. They will, however, need to provide more space and wiring capacity for microcomputers and other technologies for end-user searching of databases and individual use of microcomputers for note-taking, graphics production and general word processing within the library.

4. Intellectual Property Rights

The issue of intellectual property rights affects all of the areas under discussion today. How can one protect the rights of authors and producers while at the same time enabling users to maximize the capabilities of the new technologies? How can one credit a programmer each time his or her program is downloaded from a satellite or a compact disk? How can one establish formulas to share profits from a disk with information from several databases, or which contains 75 different journals? These are some of the very difficult questions which must be addressed in order to effectively harness the potential of these new technologies. While the cost to replicate compact disks is very low, the initial cost to press a disk is very high. This means that the information itself must be sufficiently valuable to justify the large investment to press a disk and adequately reward the creators of its intellectual content.

5. Lack of Standardization

Lack of standardization of format, equipment and search protocols are another set of issues spanning several of the storage and retrieval devices discussed today. There are several different types of CD-ROM players and interfaces, and multiple types of format and protocol for searching various online and desktop databases or using electronic mail. All of these represent barriers to the users of information; some represent costs necessary to purchase different equipment for different purposes, while others are

barriers of time and memory to learn and remember the appropriate protocols and shortcuts for using particular systems.

Lack of standardization also adds substantial cost to schools and libraries needing to have multiple types of information in desktop databases. It should be possible to have several workstations into which one could load any one of a library of compact disks. Organizations are simply not able to justify or afford a unique workstation for every database. This lack of standardization and interchangeability of disks and equipment constitutes a major problem inhibiting the expanded use of the compact disk technologies by American libraries and educational resource centers.

6. Training Needs

The issue of training has been mentioned several times in this paper, in the context of the changing role of librarians as well as the preceding reference to non-standard protocols for using various databases and online systems. Training will be an increasing need as the range of options for information storage and retrieval increases. With the general decentralization of computing functions and integrated use of various technologies for processing, storage and transmission of information, professionals in every field will use computers and databases in increasing numbers. They will need good documentation and on-screen aids to help them use these tools. Training will be an increasing part of the role of libraries and computing services organizations in order to help users maximize the resources made possible by the new information technologies.

In conclusion, we have reviewed just some of the vast changes taking place in information storage and retrieval in the United States. While computers and optical storage devices are the source of many of the developments discussed today, there are many other changes taking place in our

schools and universities. Many of the examples I have used today have come from the world of university libraries, business and the professions because the new information technologies are usually first developed where there are resources to acquire and apply them. The major challenge facing all of us in the field of educational technology is to take a leadership role in applying these new information technologies to users and learners at all levels and in all settings.

Thank you very much for the opportunity to be with you today.